On-line visual correction & makeup systems—1: Hardware

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It is important to keep clearly in mind why cathode ray tube editing and makeup systems should be considered when alternative and less costly methods are available. If we lose sight of this we may get to the position where, as with some systems of straight computer typesetting, the intellectual incentive to develop the most sophisticated configuration leads the designer to recommend a quite unrealistic installation in terms of economic viability.

The problem of correction and makeup is dealt with fairly satisfactorily with hot metal where a correction character or line, for example, can easily be inserted into a galley. With photo typeset matter the problem of introducing corrections is more difficult, involving the need to handle rather small sections of paper or film. In general, this is more time-consuming than carrying out hot metal corrections and has proved to be a stumbling-block to a wider use of such methods by the industry.

One way of using a computer to assist us is to adopt a punched tape system; and to correct the original after proof reading by merging it with a correction tape so that a perfect tape, and film, is finally produced. This merging process can be carried out in conventional off-line fashion using a computer with one or two tape readers at its input.

The correction tape must specify with precision where each alteration has to go in the main text. This tape must be accurate and unambiguous but must be relatively easy to produce. These objectives are difficult to reconcile in practice. Experience has shown that merging presents its own difficulties mainly because corrections or makeup requirements often alter the copy to such an extent that further errors are introduced which have to be rectified in turn. This involves a further correction tape and processing pass and so on resulting, perhaps, in three or more alterations before an acceptable result is finally produced. The need for several passes and proofing stages can easily make the whole process quite unattractive even when using a small computer installation.

Requirements for page makeup, for example, dividing up into pages, inserting headings, page numbers, blocks, etc, involve considerable handling of film or metal. Tape merging techniques can, of course, also be used in this case but the basic difficulties persist. The advantages of correcting directly with hot metal are that position is easy to specify and that the corrections can be checked after insertion and any consequences noted and put right. It would be desirable to evolve equipment for correction and makeup which possesses these features and makes the whole process easier for film.

A system, suitable for bookwork, which meets these requirements in some measure, is being closely studied by the computer typesetting department of Elliott-Automation Ltd. This makes use of a small general purpose computer particularly well suited to typesetting applications—the 903—with 8,192 words of 18-bit main store. This machine is coupled on-line to a CRT display, positioning device and operator's keyboard. The display will show to the operator a page of text read in from punched tape at the input to the computer. Using his positioning device, the operator will be able to indicate by means of a movable marker or cursor any character or position in the text and by further keying operations to introduce corrections and then to observe the consequences of these corrections.

The system outlined in the preceding paragraph includes one other important feature, taking the form of a buffer store. This buffer consists of a 4,096, 6-bit word core store and drives the display in a cyclic manner. The computer can gain immediate access to the store if it is required to alter any section after a correction for example. A character generator provides both upper and lower case characters and a range of special symbols and it can be driven either from the buffer store or direct from the computer. In this way a display can be sustained on the screen without direct intervention of the computer or the computer can supplement the display with additional characters or symbols, if necessary.

The system

The two characteristics of the CRT which are of importance are phosphor performance and size of face. The latter will be considered within the context of screen format. The prime requirement for the phosphor is that under no circumstances must the display flicker, otherwise the operator will be distracted and will suffer strain if he uses the display for an extended period. In order to avoid any likelihood of flicker the paint rate should exceed about 30/sec although this figure can probably be reduced if the ambient lighting conditions are adjusted.

If, however, the amount of data presented on the screen and the character generation speed are such that the paint rate must be less than this flicker limit, it is necessary to use a long-persistence phosphor. In this way paint rates of less than 10 per second can be readily accommodated without flicker provided that the phosphor has a fairly level intensity of visible illumination during persistence. When phosphors are mixed so as to produce a short brilliance flash after regeneration to operate a light pen, for example, appreciable flicker may be observed even with long

persistence types. The effect of the flash can be nullified by interposing a suitable filter, usually yellow, between the operator and the screen, but this makes the use of the light pen unmanageable.

If it is necessary to use a light pen in such a system, a flash which exists only in the ultra-violet or infra-red region of the spectrum has to be used. Suitable phosphors with these characteristics are now becoming available so that the need to use a light pen will not impose restrictions on paint rate.

When the phosphor light output is allowed to decay it is important that this happens with a relatively short time constant so that if the screen contents are changed then the new data is easily discernible after only a brief delay. Probably a decay time of about one second or less is quite acceptable here. If it is longer, then the blurring effect after a change of screen contents becomes significant in assessing the speed with which the operator can use the system.

Screen size and format

It is probably true to say that within limits the larger the tube used the more generally useful will be the display. The cost aspect must be kept in mind since suitable large tubes can present special problems regarding shape, mounting and safety, etc, so that some intermediate size might prove to be the optimum. If it is assumed that at least an average book page should be completely accommodated on the screen then a format of about 60 lines with up to 100 characters in a line is indicated. The average character content of a page may be about 3,000 to 4,000 so that a buffer capacity of 4,096 would be appropriate. If the content exceeds this figure it is possible to supplement the buffer by direct output from computer, but this facility is probably limited to 100 or 200 characters determined by the time available within the central processor. Although it would be desirable to accept even larger pages for complete display it is likely that 80–90 per cent of the work can be dealt with adequately with a capacity of up to 4,300 characters. For larger page sizes a technique for handling partial pages would require to be developed, but this will have greater implications for makeup than correction.

Evidence available relating to character size indicates that 10/inch is acceptable provided that the shape is well formed. This corresponds to line printer and typewriter output density which is satisfactory when read from the distance considered normal when reading or typing. For a format of 60 lines each of up to 100 characters at 10/inch a tube of 17″ diagonal is indicated. By using the tube turned 90° from its normal direction, so that the horizontal usable length is 10″ and the vertical length 13″, it is possible to accommodate the 60 lines with sufficient leading to keep them clearly separated and to allow a marker to be moved between them.

The use of a tube larger than 17″ diagonal does not necessarily lead to a larger capacity, since legibility of characters of a given size is adversely affected by beam spot size and this tends to increase with size of screen. Another factor to be borne in mind is non-linear distortion effects which, amongst other things, will tend to defocus the spot towards the periphery of the tube face. These effects can be overcome by coil design or by avoiding the use of wide-angle tubes of the television type, so that by adopting a CRT with maximum angle of 55°–70° the useful face area will extend to the periphery with relatively little degradation. This type of tube, however, tends to be very bulky, difficult to mount and handle and is inevitably expensive both from the initial cost and replacement cost points of view.

Character generation

Various methods have been developed for the high speed generation of character shapes on the face of the CRT. Apart from tracing by rasters, dots or vectors, special tubes of the monoscope type have been used. Although all these methods can yield characters which are quite legible it seems unlikely that anything really approaching graphic arts quality will be possible at the present stage, since the necessary rate demands character generators with a capability of at least 50,000 per second to allow a book page to be repainted every 80 to 100 msecs when a long-persistence phosphor is used. Of course, if suitable phosphors with persistence times of the order of one second are developed with an adequate decay characteristic, it might be possible to reduce the generation rate to the point where video techniques now being considered for high speed photo typesetters will become relevant.

We are limited therefore to considering rather basic characters in one font only in upper and lower case with a number of additional symbols making a total of 90 to 100 shapes. There is ample subjective evidence to indicate that such characters are in fact quite legible even if they are not aesthetically pleasing. An important feature of editing and makeup display systems has to be appreciated here, in that the operator can tolerate a relatively low level of character representation, if he is not called upon to read and comprehend the text rather than perform what is, in effect, a clerical function. This is the case if the displayed text is accompanied by an identical printed text previously edited and bearing correction instructions. For this reason there would be no serious intention of expecting an operator to carry out the function of proof reading and correction at the display. These two processes would be treated quite separately as at present.

As far as generation speed is concerned two factors to be considered are the cost of the generator and the effect that the speed will have on the drive and deflection circuitry at the tube. Very high rates will require high power drivers and may also involve some extra complexity in coil design so that for economy reasons a minimum-speed generator system should be considered.

Position indicator

Four possible methods of allowing the operator to indicate textual position on the screen are available. These comprise: light pen, rolling ball, joystick and keyboard. The light pen appears superficially advantageous since it approximates most closely to the method we use to mark text under normal circumstances. It also allows us to move across the text in a very direct manner virtually unimpeded. It must be remembered, however, that the operator can only input corrections by keyboard and

not by light pen (except in a very limited way) and the need for him to alternate between the use of the light pen and the keyboard makes this an inconvenient method of indicating position. Additional disadvantages are that the light pen tends to be a rather imprecise pointer and its use necessitates a phosphor with a short-persistence flash which, as described earlier, can cause flicker trouble.

The tracker ball and joystick methods of indication are really quite comparable in performance and implementation. Without adequate subjective experience it is rather unsafe to be dogmatic about their relative merits. Both are relatively inexpensive compared with the light pen and allow a fairly rapid movement of the marker. Since they can be placed close to the keyboard they allow the operator to move his hand from one to the other with relatively little wasted effort.

The most direct method of controlling marker position is to make use of specially assigned keys on the keyboard. Four keys would be reserved to allow movement up and down on a single- and repetitive-step basis. Although this method is the most economical to implement it has proved to be rather restrictive and time-consuming in that it may take up to ten seconds to move from one extreme position in the display to another. With the other methods it seems less difficult for the eye to follow the marker movement so that time is shortened to a reasonable level.

Keyboard

The point that is worth considering is the kind of special facilities which the keyboard can present to the operator to allow him to instruct the central processor about his intentions. The most direct approach would be to provide a set of separate keys each of which would instruct the machine regarding a particular correction or makeup function. Such functions might include:

1 delete
2 substitute
3 transpose
4 store and delete
5 insert
6 line release
7 insert folio number, etc.

An alternative approach allowing an unmodified keyboard to be used would make use of the normal keys preceded by an 'instruct' key to indicate special functions. Because of the number of such functions and the frequency with which they would have to be used it is likely that this approach could lead to operator confusion with a consequent overall reduction in productivity.

System capability

A correction and makeup display system incorporating the various features outlined in the previous section will prove a powerful tool in the hands of a trained operator for practically all functions at present carried out by hand on metal, film or paper. It will be possible to indicate any position or section of text and make insertions, deletions or transpositions. If any changes lead to an alteration in the justifying situation it will be possible for the operator to monitor the re-justification condition, to check any new hyphenations and generally to manipulate the text in a relatively unrestricted manner. The most important feature of the system will be, of course, the ability to check that alterations have been correctly introduced and to rectify any possible ill-effects.

Most forms of makeup will be carried out using the display system in some case more or less automatically where the operator will act purely as a monitor. For instance correct insertion of page or folio numbers, pagination or insertion of headings will easily be possible. Insertion of extra leading sometimes required for page makeup can also be carried out perhaps with or without operator assistance.

The whole area of merging or inserting new matter into text, whether it be adding footnotes, inserting blocks or updating an index or catalogue by small or massive addition, should be amenable to this display technique.

The effective cost of carrying out corrections and makeup with such a display system depends to what extent full use of the central processor can be made. Since the operator's reaction time really determines the necessary overall speed of the system it is likely that the processor will not be heavily loaded by a single display. In order to reduce operating costs an attempt should be made to operate the system on a multi-program, multi-access basis. Using a 903 in this way it is possible to operate one or two displays as well as an off-line justifying and hyphenating channel. The latter would be used for the initial run to produce a justified tape for driving the typesetter and would proceed at the same time as the display channels.

The most important point, of course, is not whether such a system can be developed in hardware and software terms—of this there is little doubt now—but whether it can be shown by an accurate cost evaluation that it is worthwhile to do so. In other words, it is important to try to show at an early stage that cost per correction using the display approach compares favourably with cost per correction using the conventional approach. In practice the situation is very unlikely to be as clear-cut as this. There will be problems in assessing long-term operator productivity using such a novel system and there will be many fringe benefits associated with a system of this flexibility that will have to be taken into account.

Although the system described here is oriented to book production, it is inevitable that its use will be extended, in time, to the newspaper field. The problems in this case are different in degree rather than principle, although the requirement for full page makeup involves an even more complex system where shapes could be manipulated and moved around the screen. In daily newspaper production, time is an all-important factor. In a relatively short period a large quantity of material has to be read and corrected, which means that the computer system will require a peak capacity much greater than the average throughput. The implication is that a parallel correction facility would have to be available consisting of many inexpensive but capable displays.